Towards green gases solutions for industry

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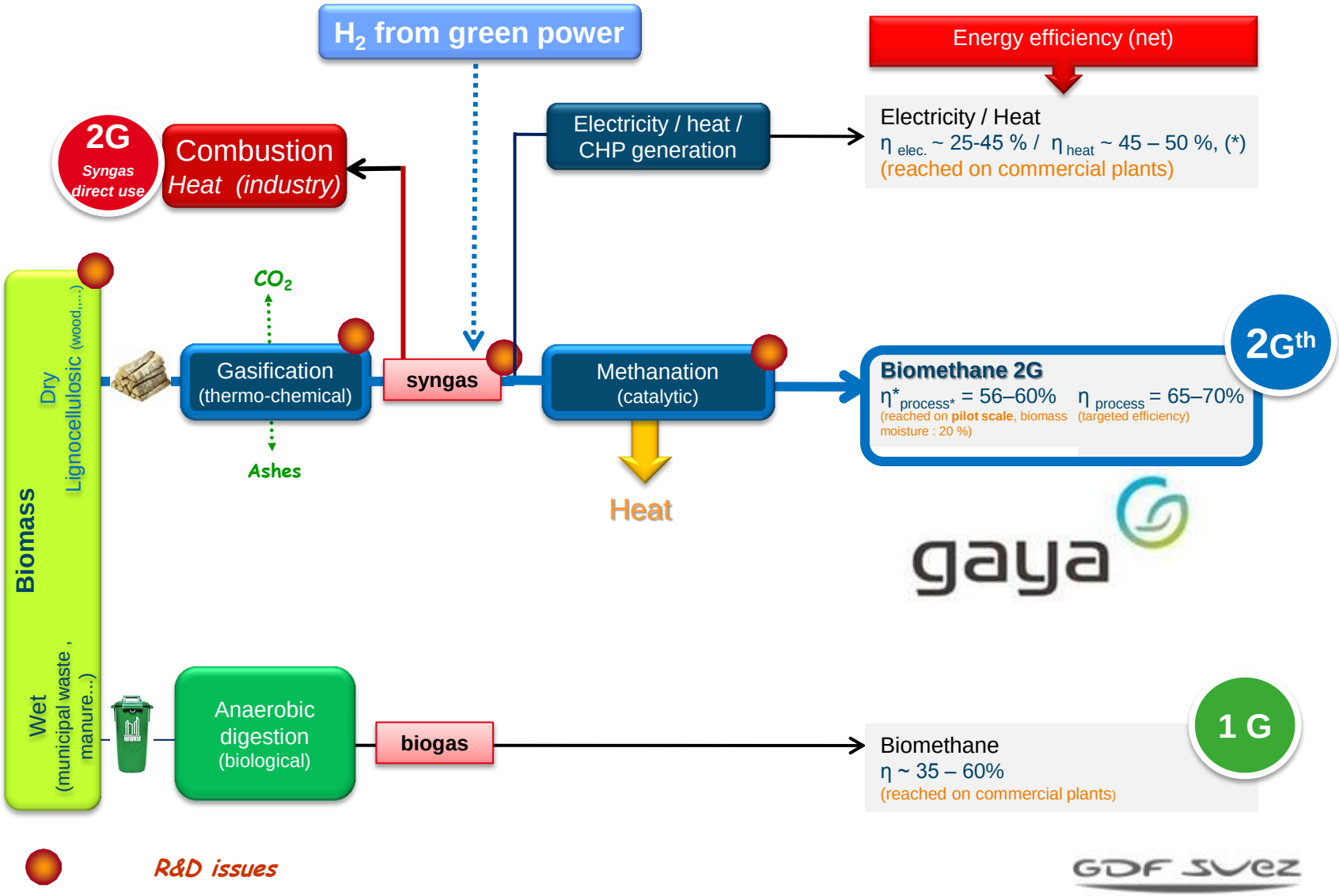
Renewable energy corporate programm – Green Gases

How to produce Green Gases from Biomass ?



**Assessment based on opérationnal data from Güssing CHP plant (Austria)*

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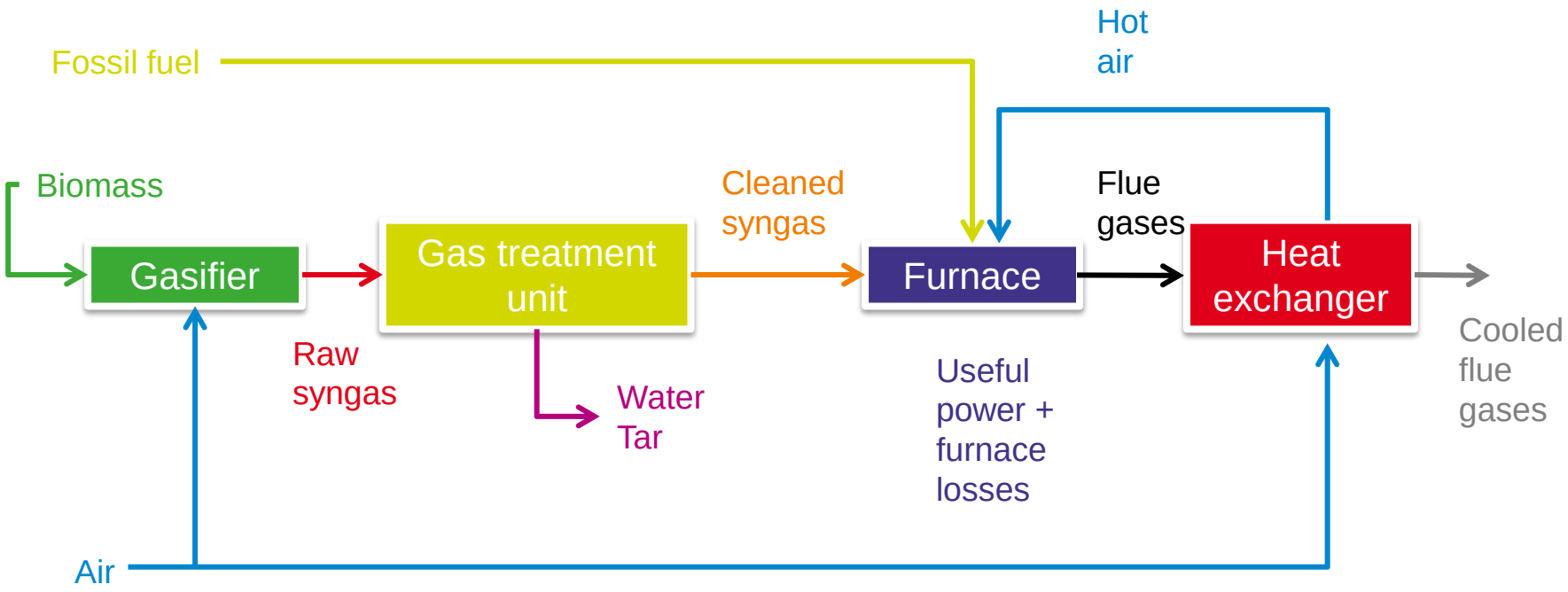
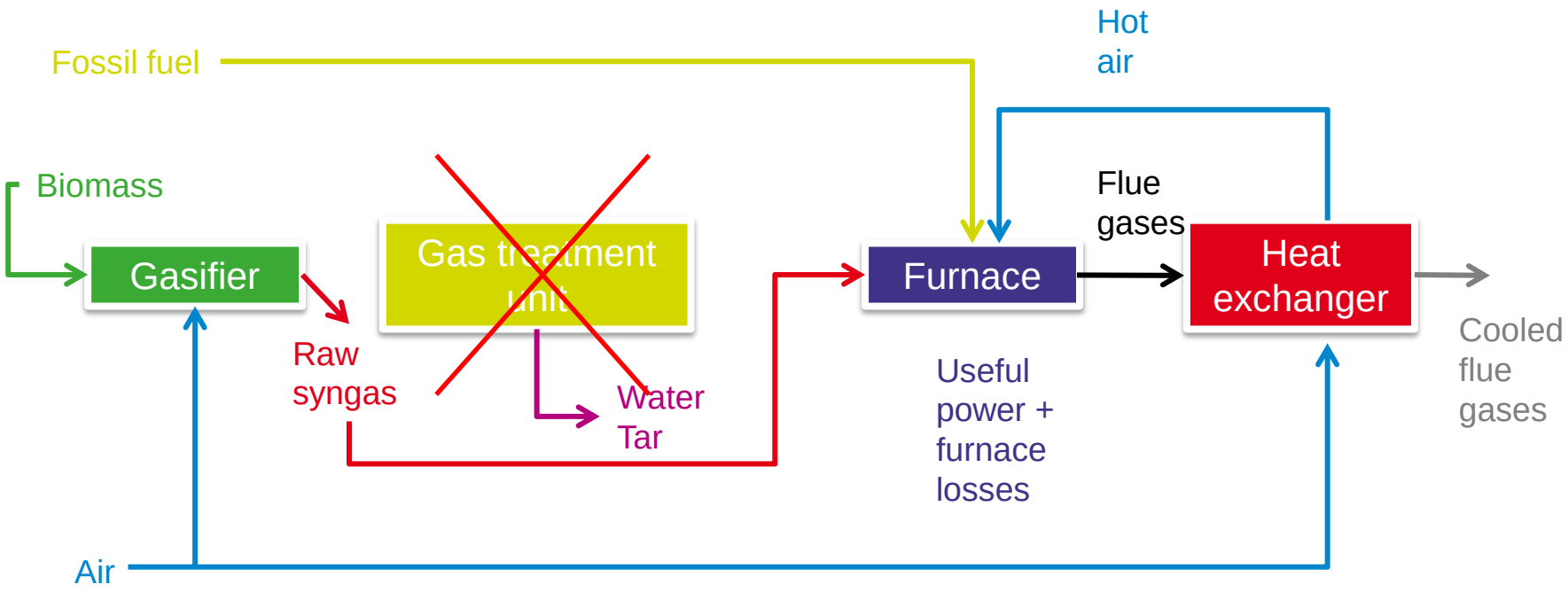
Principle of the coupling of a gasifier unit and an industrial furnace

Configuration #1 : cleaned syngas



Principle of the coupling of a gasifier unit and an industrial furnace

Configuration #2 : raw syngas



Gasifier technology choice (1)

- Syngas is generated by low-temperature (<1000°C) gasification.
- The main direct and indirect processes are:
  - Fixed-bed updraft;
  - Fixed-bed downdraft;
  - Fluidized bed (bubbling and circulating, i.e. BFB and CFB); and
  - Indirect fluidized bed (steam-blown).
- Combustion and properties depend on the gasifier technologies
- Tar concentration in the downdraft gasifier is low ➔ for special application with engines, tars concentration can be strongly reduced up to less than 100 mg/Nm^3
- Power range of most industrial furnace is between 100 kW and 10 MW

  ➔the thermal output power of the gasification unit has to match with furnace power

"crigen

Syngas composition and combustion properties

% mol	H_2	CO	CH_4	C2+	CO_2	N_2	LCV kWh/Nm3
Fixed-bed downdraft composition	17	22	2	0	11	45	1,4
Fluidized bed composition (steam-blown)	38	25	11	2,6	21	2,5	3,5

	LCV kWh/Nm3	Air volume (Nm3 air / Nm3 fuel)	Fumes volume (Nm3 fumes / Nm3 fuel)
Natural Gas	10.25	9.8	10.8
Syngas (downdraft)	1.51	1.15	1.94

- Syngas flame temperature can reach 2050°C with preheated air up to 1300°C

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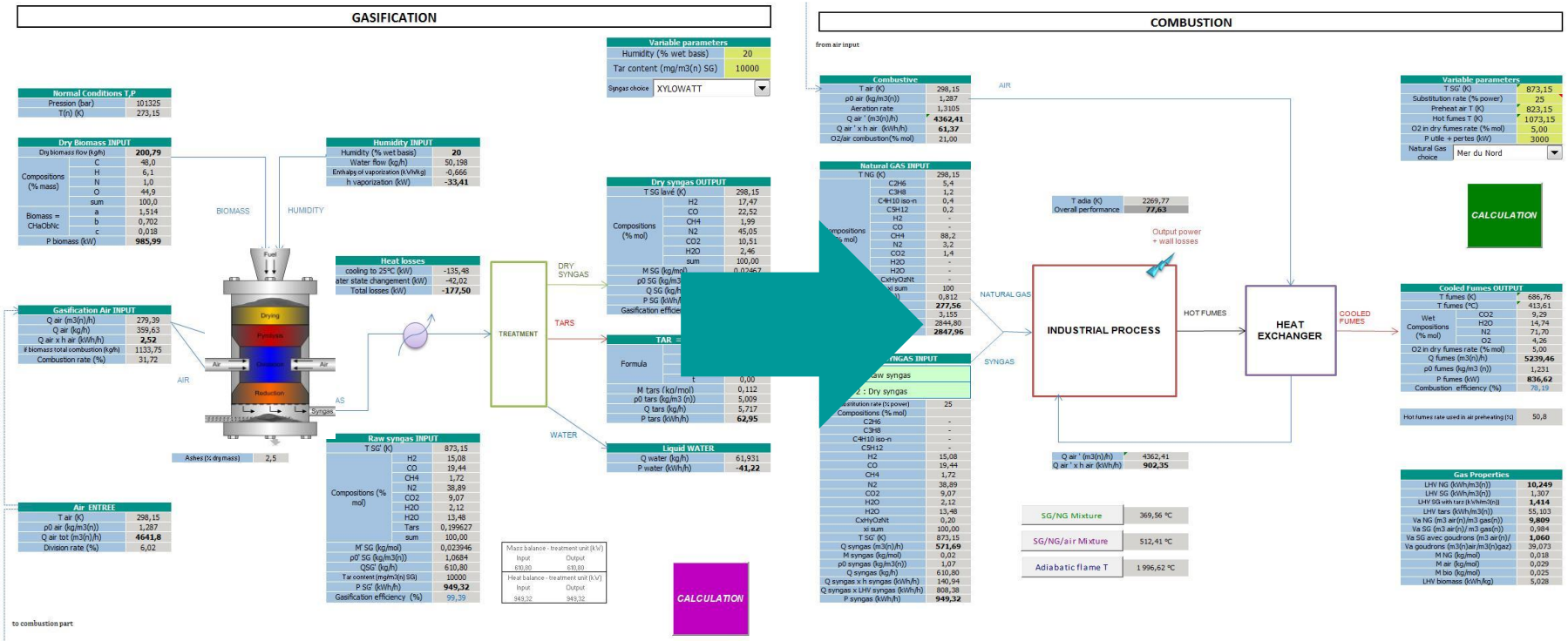
Gasifier technology choice (2)

- The simplest and cheapest gasification technologies are the most appropriate for direct firing.

- Fixed bed downdraft technology is a good candidate
  - very sensitive to the biomass particle size and requires very low humidity (< 10%).
  - large gasifiers (> 4 MW) are not developed ➔ development under way to increase the gasifier diameters and output power

- Syngas LCV is low:
  - flue gas volume is largely increased
  - flame temperature and energy efficiency are decreased
  - energy efficiency of the whole installation is reduced.
  - several works are currently under way o increase the LCV with the use of oxygen instead of gasification air

Model developed by CRIGEN to evaluate the feasibility of syngas firing for processes



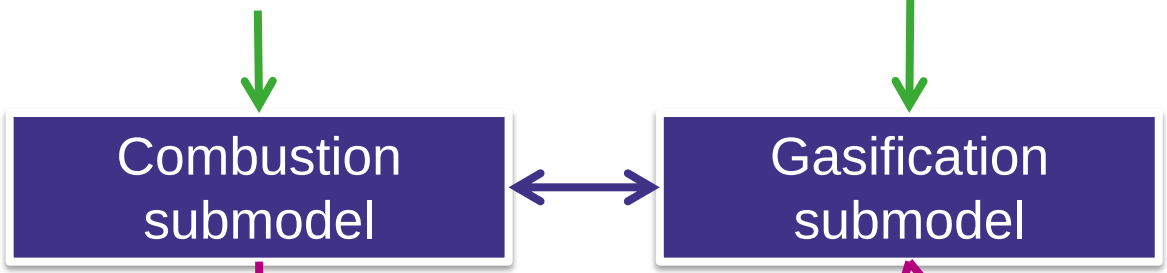
- Two sub-models solving mass flow and energy equations
  - Gasification (simplified) model
  - Combustion (simplified) model

Model developed by CRIGEN to evaluate the feasibility of syngas firing for processes

Inputs

- Fuels
- % O_2 in dry fumes
- Useful power + losses
- Air preheating temperature
- Fumes temp. at furnace outlet
- Syngas temp. before cleaning)
- Syngas substitution rate

- Biomass humidity
- Cleaned syngas composition
- Biomass content
- Tar concentration in raw syngas



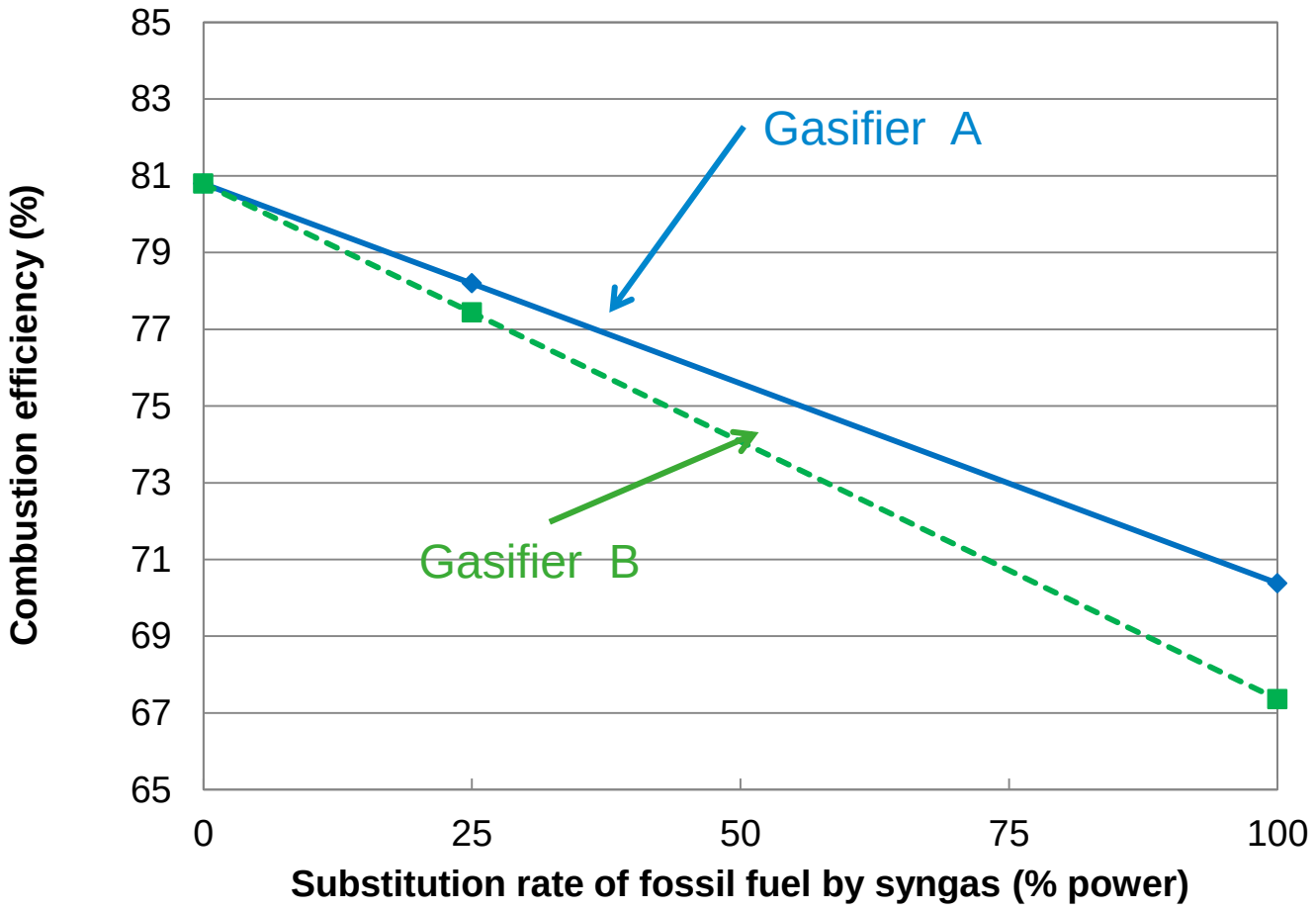
Outputs

- Fossil fuel flow rate
- Syngas flow rate
- Combustion air flow rate
- Fumes temperature after recovery
- Combustion efficiency

- Biomass input power
- Syngas output power
- Raw syngas output power
- Raw syngas composition
- Gaseifier yield
- Overall efficiency

- Air flow rate
- Water content
- Tar flow rate
- Tar formula
- Raw syngas flow rate
- Biomass flow rate

Model results



BioViVe project's set-up and objectives

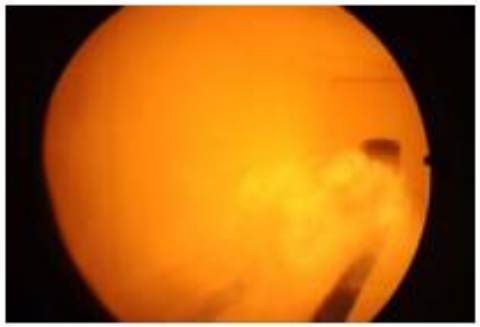
- **R&D project supported by the French National Research Agency (ANR)**
- **Project led by Saint-Gobain Verallia, with**
- **4 partners: Xylowatt, GDF SUEZ, CIVC, CIRAD**
- **Project objectives:**

1. **Produce a synthetic gaseous fuel coming from vine wood:**
   - Compatible with the glass melting process
   - Directly usable in a furnace in replacement of fossil fuels
2. **Determine the design principles of a glass furnace using up to 50% of biomass energy:**
   - Laboratory tests and combustion trials in a 2 MW combustion cell
   - 12 months of industrial testing while producing glass
3. **Create a sustainable network for collecting vineyard waste wood in the Champagne area**

Implementation of the gasifier for combustion test

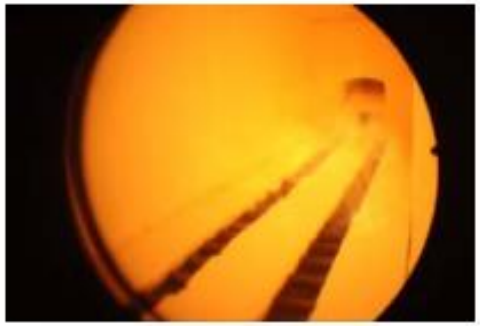
Detailed characterization of syngas combustion

- 4 weeks of trial for a comprehensive characterization of air combustion of biomass syngas in CRIGEN's 2 MW combustion facility, representative of a glass furnace
- Reference trial with 100% natural gas
- Preheated air combustion, natural gas / air-gasified syngas, up to 100% of syngas
- Oxy-gasified syngas mixed with natural gas



Natural gas

25% syngas



50% syngas

Conclusions

- CRIGEN has successfully tested the firing of green gases from biomass on a facility reproducing conditions of an industrial process.
- A large range of industrial processes can run with syngas from biomass as a substitution of fossil fuel to reduce their CO_2 emissions
- Keeping a small input of natural in the process gas can be required especially for high temperature furnaces
- Use of local biomass is required for a good sustainability
- Specific safety measures are needed to handle the presence of CO and H2 in the syngas

The GAYA R&D Project: towards industrialization of 2G

Enable the potential of 2G Biomethane

2011 — **R&D** Lab Concept → 2017 — **R&D Pilot** → 2020 — **Industrialization**

gaya

400 kW_{bioSNG}

30 Nm^3/h

20 à 80 MW_{bioSNG}

2 000 - 8 000 Nm^3/h

- Validate at pilot scale **a integrated portfolio of technology solutions** to **support industrial deployment** of 2nd generation Biomethane pathway
- A project with an **integrated vision of the pathway** *: "from biomass to injection in the grid"*
- Develop a **profitable industry** by 2017 → **need to reach competitive costs for 2G Biomethane**
- Support the development of a regulatory framework and an incentive context at European level

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The GAYA Demo Platform

Status and agenda

2011 → Kick Off

2012 → 1st eng studies
Location site

2013 → Permitting / 1st stone
Basic eng

2014 → Detail eng / contracting
Civil work

2015 → 1st blocks deliveries

2016 → Inauguration

R&D / Demo Phase

2017

2018 → End of the project